SPECTRAL AMPLITUDE CODED-OCDMA QKD FOR MULTIPLE ACCESS NETWORK

Precious Ogbonda **AMADI**

Institute of Engineering Mathematics, Universiti Malaysia Perlis
02600 Arau, Perlis, Malaysia
Orcid number: 0000-0003-3691-3891
amadiwati@gmail.com

Syed Alwee **ALJUNID**

Faculty of Electronic Engineering & Technology, Universiti Malaysia Perlis
02600, Arau, Perlis, Malaysia
Orcid number: 0000-0003-2739-6220
syedalwee@unimap.edu.my

Norshamsuri **ALI**

Faculty of Electronic Engineering & Technology, Universiti Malaysia Perlis
02600, Arau, Perlis, Malaysia
Orcid number: 0000-0002-9348-0714
norshamsuri@unimap.edu.my

Norshamsuri **ALI** Faculty of Electronic Engineering & Technology, Universiti Malaysia Perlis
02600, Arau, Perlis, Malaysia
Orcid number: 0000-0002-9348-0714
norshamsuri@unimap.edu.my

Mohammad Ammar **SYED**

Faculty of Electronic Engineering & Technology, Universiti Malaysia Perlis
02600, Arau, Perlis, Malaysia
Orcid number: 0000-0002-3630-2583
syammar@studentmail.unimap.edu.my

Rosdisham **ENDUT**

Faculty of Electronic Engineering & Technology, Universiti Malaysia Perlis
02600, Arau, Perlis, Malaysia
Orcid number: 0000-0003-3659-9740
rosdisham@unimap.edu.my

Nursalasawati **RUSLI**

Institute of Engineering Mathematics, Universiti Malaysia Perlis
02600, Arau, Perlis, Malaysia
nursalasawati@unimap.edu.my

Abdulrahman M. **ALHASSAN**

Electrical Engineering, Abu Dhabi University
United Arab Emirates
Orcid number: 0000-0003-1710-8985
nursalasawati@unimap.edu.my

Abstract

We present a theoretical framework and analysis of a hybrid multi-user quantum key distribution (QKD) system utilizing spectral amplitude coding optical code division multiple access (SAC-OCDMA) encoding techniques. By assigning unique optical codes to each user, SAC-OCDMA enables spontaneous, asynchronous data transmission without requiring strict synchronization, making it scalable and flexible for quantum networks. In the architecture, each user's quantum signal, initially prepared as weak coherent pulses and encoded using phase or polarization bases, is further spectrally sliced by a SAC-OCDMA encoder in a zero-based cross-correlation code. The physical impairments, comprising spontaneous Raman scattering, four-wave mixing, and crosstalk, were modeled and analyzed. We report a maximum secret key rate of $\sim 10^5$ bps over a transmission distance of ~ 58 km. Furthermore, our analysis demonstrates that careful selection of launch power, simultaneous users, code weight, and spectral bin width is necessary for optimizing the trade-off between multi-user capacity and security performance. In comparison with wave division multiplexing QKD, which has much better spectral efficiency, but strict channel allocation, the flexibility and asynchronous access to secure communication of our OCDMA-QKD design, with zero cross-correlation coding, is more aligned with the needs of quantum security